

# THALLIUM

## FACT SHEET



See related Fact Sheets: Acronyms & Abbreviations; Glossary of Terms; Cost Assumptions; Raw Water Composition; Total Plant Costs; and WaTER Program.

### 1. CONTAMINANT DATA

**A. Chemical Data:** Thallium (Tl), atomic number: 81, atomic weight: 204.37, oxidation states: +3, and +1, soft, malleable, inelastic metal resembling lead in appearance. Becomes bluish-gray tinge when exposed to air. Very poisonous with not many uses. Odorless and tasteless, and gives no warning of its presence. It is a member of the aluminum family of metals. Tl and its compounds have water solubilities ranging from low to high, depending on the salt formed. Tl alone is highly persistent in water, as it has only slight solubility.

**B. Source in Nature:** Tl does not occur in the elemental state, but is found in trace amounts in the earth's crust as ores in potash minerals or as a by-product from the smelting of metals such as pyrites, zinc, blende, and hematite. It can also be found combined with other substances such as bromine, chlorine, fluorine, and iodine. Tl has been detected in volcanic rocks, meteorites, and plants. It occurs in small amounts in all living organisms.

**C. SDWA Limits:** MCL for Tl is 0.002 mg/L and the MCLG is 0.0005 mg/L.

**D. Health Effects of Contamination:** Tl at short-term exposure levels above the MCL can cause vomiting, diarrhea, gastrointestinal irritation, peripheral neuropathy. Long-term exposure at levels above the MCL, Tl can cause changes in blood chemistry, liver and kidney damage, damage to intestinal and testicular tissues, and hair loss. Contact with the metal with skin is dangerous. It has caused death.

### 2. REMOVAL TECHNIQUES

**A. USEPA BAT:** Activated alumina or ion exchange.

! AA uses extremely porous and highly adsorptive aluminum ore media to adsorb Tl. Benefits: containment of Tl in adsorption bed. Limitations: when used with  $Tl^{+4}$  results in creation of hazardous waste requiring disposal. AA cost curves will be included in a future revision.

! IX for soluble Tl uses charged cation resin to exchange acceptable ions from the resin for undesirable forms of Tl in the water. Benefits: effective; well developed. Limitations: restocking of salt supply; regular regeneration; concentrate disposal.

**B. Alternative Methods of Treatment:** Distillation (for home drinking water only) heats water until it turns to steam. The steam travels through a condenser coil where it is cooled and returned to liquid. The Tl remains in the boiler section. Alternately, solid block or precoated absorption filters made with carbon or activated alumina certified to reduce Tl are available.

**C. Safety and Health Requirements for Treatment Processes:** Personnel involved with demineralization treatment processes should be aware of the chemicals being used (MSDS information), the electrical shock hazards, and the hydraulic pressures required to operate the equipment. General industry safety, health, and self protection practices should be followed, including proper use of tools.

### 3. BAT PROCESS DESCRIPTION AND COST DATA

**General Assumptions:** Refer to: Raw Water Composition Fact Sheet for ionic concentrations; and Cost Assumptions Fact Sheet for cost index data and process assumptions. All costs are based on *ENR*, PPI, and BLS cost indices for March 2001. General sitework, building, external pumps/piping, pretreatment, or off-site sludge disposal are not included.

### **3A. Activated Alumina:**

Process - AA uses an extremely porous media in a physical/chemical separation process known as adsorption, where molecules adhere to a surface with which they come into contact, due to forces of attraction at the surface. AA is a media made by treating aluminum ore so that it becomes porous and highly adsorptive, and is available in powder, pellet, or granule form. The media is activated by passing oxidizing gases through the material at extremely high temperatures. This activation process produces the pores that result in such high adsorption properties.

Contaminated water is passed through a cartridge or canister of AA. The media adsorbs the contaminants. The adsorption process depends on the following factors: 1) physical properties of the AA, such as method of activation, pore size distribution, and surface area; 2) the chemical/electrical nature of the alumina source or method of activation and the amount of oxygen and hydrogen associated with them, such that as the alumina surfaces become filled the more actively adsorbed contaminants will displace the less actively adsorbed ones; 3) chemical composition and concentration of contaminants effect adsorption, such as size, similarity, and concentration; 4) the temperature and pH of the water, in that adsorption usually increases as temperature and pH decreases; and 5) the flowrate and exposure time to the AA, in that low contaminant concentration and flowrate with extended contact times increase the media life. AA devices include: pour-through for treating small volumes; faucet-mounted (with or without by-pass) for POU; in-line (with or without by-pass) for treating large volumes at several faucets; and high-volume commercial units for treating community water supply systems. Careful selection of alumina to be used is based on the contaminants in the water and manufacturer's recommendations.

Pretreatment - With bacterially unstable waters, filtration and disinfection prior to AA treatment may be required. With high TSS waters, prefiltration may be required. If treatment is based on flowrate, a water meter may be required to register total flowrates.

Maintenance - Careful monitoring and testing to ensure contaminant removal is required. Regular replacement of media may be required and is based on contaminant type, concentration, and rate of water usage. The manufacturer's recommendations for media replacement should be consulted. Recharging by backwashing or flushing with hot water (145°F) may release the adsorbed chemicals, however this claim is inconclusive. Periodic cleaning with an appropriate regnerant such as  $\text{Al}_2(\text{SO}_4)_3$ , acid, and/or caustic will extend media life. With bacterially unstable waters, monitoring for bacterial growth is required because the adsorbed organic chemicals are a food source for some bacteria. Flushing is required if the AA filter is not used for several days, and regular backwashing may be required to prevent bacterial growth. Perform system pressure and flowrate checks to verify backwashing capabilities. Perform routine maintenance checks of valves, pipes, and pumps.

Waste Disposal - Backwash/flush water disposal is required if incorporated. Disposal of spent media is the responsibility of the contractor providing the media replacement services.

#### Advantages -

- ! Well established.
- ! Suitable for some organic chemicals, some pesticides, and THMs.
- ! Suitable for home use, typically inexpensive, with simple filter replacement requirements.
- ! Improves taste and smell; removes chlorine.

#### Disadvantages -

- ! Effectiveness is based on contaminant type, concentration, and rate of water usage.
- ! Bacteria may grow on alumina surface.
- ! Adequate water flow and pressure required for backwashing/flushing.
- ! Requires careful monitoring.

Costs - The BAT costs curves for AA equipment and annual operation and maintenance are being developed and will be included in a future revision.

### 3A. Ion Exchange:

**Process** - In solution, salts separate into positively-charged cations and negatively-charged anions. Deionization can reduce the amounts of these ions. Cation IX is a reversible chemical process in which ions from an insoluble, permanent, solid resin bed are exchanged for ions in water. The process relies on the fact that water solutions must be electrically neutral, therefore ions in the resin bed are exchanged with ions of similar charge in the water. As a result of the exchange process, no reduction in ions is obtained. In the case of Tl reduction, operation begins with a fully recharged cation resin bed, having enough positively charged ions to carry out the cation exchange. Usually a polymer resin bed is composed of millions of medium sand grain size, spherical beads. As water passes through the resin bed, the positively charged ions are released into the water, being substituted or replaced with the Tl ions in the water (ion exchange). When the resin becomes exhausted of positively charged ions, the bed must be regenerated by passing a strong, usually NaCl (or KCl), solution over the resin bed, displacing the Tl ions with Na or K ions. Many different types of cation resins can be used to reduce dissolved Tl concentrations. The use of IX to reduce concentrations of Tl will be dependant on the specific chemical characteristics of the raw water.

Cation IX, commonly termed water softening, can be used with low flows (up to 200 GPM) and when the ratio of hardness-to-Tl is greater than 1.

**Pretreatment** - Guidelines are available on accepted limits for pH, organics, turbidity, and other raw water characteristics. Pretreatment may be required to reduce excessive amounts of TSS which could plug the resin bed, and typically includes media or carbon filtration.

**Maintenance** - The IX resin requires regular regeneration, the frequency of which depends on raw water characteristics and the Tl concentration. Preparation of the NaCl solution is required. If utilized, filter replacement and backwashing will be required.

**Waste Disposal** - Approval from local authorities is usually required for the disposal of concentrate from the regeneration cycle (highly concentrated alkaline solution); occasional solid wastes (in the form of broken resin beads) which are backwashed during regeneration; and if utilized, spent filters and backwash waste water.

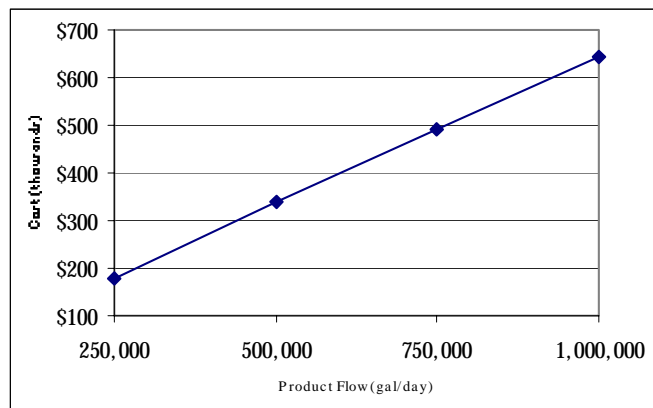
#### Advantages -

- ! Acid addition, degasification, and repressurization is not required.
- ! Ease of operation; highly reliable.
- ! Lower initial cost; resins will not wear out with regular regeneration.
- ! Effective; widely used.
- ! Suitable for small and large installations.
- ! Variety of specific resins are available for removing specific contaminants.

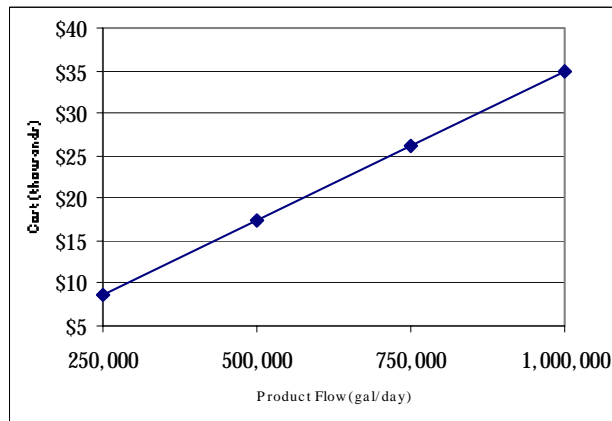
#### Disadvantages -

- ! Pretreatment lime softening may be required.
- ! Requires salt storage; regular regeneration.
- ! Concentrate disposal.
- ! Usually not feasible with high levels of TDS.
- ! Resins are sensitive to the presence of competing ions.

**BAT Equipment Cost\***



**BAT Annual O&M Cost\***



\*Refer to Cost Assumptions Fact Sheet. Does not include general sitework, building, external pumps/piping, pretreatment, or off-site sludge disposal.